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INVESTIGATION OF THE MOON WITH ROCKET APPARATUS

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INVESTIGATION OF THE MOON WITH ROCKET APPARATUS

(USSR)

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Soviet science and engineering has once again won two brilliant victories in a systematically conducted attack on space.

On the morning of 12 September 1959 at about 10 o'clock, Moscow time, a powerful multistage rocket took off from the launching pad, carrying scientific-research equipment for the study of the moon and cosmic space on the path of the rocket from the earth to the moon. After it had once reached the sky, the rocket gradually attained the first, then the second cosmic speed and finally exceeded it. The trajectory of the flight was selected after estimating the direct impact of the space rocket and the moon at less than 38-1/2 hours after the take-off.

The rocket reached the surface of the moon on 14 September at 00 hours, 02 minutes, 24 seconds, Moscow time. The radio sets installed on board the rocket announced to the entire world the completion of the greatest step in the conquest of space. For the first time the creation of man's hands according to the will of its creators cut across one of the regions of space and reached the heavenly body which is closest to us -- the moon.

The last stage of the space rocket weighed 1511 kg [kilograms] (without fuel), including the weight of the container with the scientific and radio-technical apparatus. The total weight of the scientific and measuring apparatus, with the power sources and container, was 390.2 kg.

The spherical metal container was hermetically sealed, filled with nitrogen, and equipped with a system for automatic control of the heating cycle. After the rocket had been put into orbit, the container was separated from the last stage of the rocket in order to ensure more favorable conditions for housing the scientific apparatus with which they would successfully investigate the magnetic field of the earth and moon, the radiation belts around the earth, the intensity and variations of intensity of cosmic radiation, heavy nuclei in cosmic radiation, gas components of inter-planetary substances, and meteoric particles.

Three radio transmitters, working on five frequencies, were installed on board the rocket in order to transmit to earth the results of scientific measurements and operating conditions of the measuring and radiotechnical equipment (temperature and pressure in the container) as well as information on the movement of the space rocket. The radio transmitter installed on the last stage of the rocket worked with coded transmissions lasting from 0.8 to 1.5 seconds alternately on frequencies 20.003 and 19.997 mgts [megacycles]. Radio observations of the flight of the last stage of the rocket as well as additional scientific information about the intensity of cosmic radiation, received from the apparatus on board the final stage, were transmitted on the radio channel of this transmitter.

One of the radio transmitters installed in the container worked on the frequencies 19.993 and 39.986 mgts with signals in the form of impulses lasting from 0.2 to 0.8 seconds with a pulse repetition rate of 1$\pm$0.15 gts [hertz]; the other radio transmitter worked on the frequency 183.6 mgts. Both radio transmitters served to transmit to the ground telemetering stations the data of the scientific observations carried out in flight, including temperature and pressure inside the container. Moreover, constant measurements of the distance to the container with the apparatus, angular coordinate (tilt and azimuth angle), and the radial speed of the container (from the measuring point) were transmitted on the frequency 183.6 mgts.

The power of the transmitters on board the rocket made it possible to receive their signals not only with the basic measuring apparatus, but by a large number of radio amateurs and radio centers in the various countries.

In order to observe visually the movement of the rocket in cosmic space, apparatus was installed on the rocket in order to create a sodium cloud (artificial comet) at an earlier designated moment of time -- 12 September at 21 hours, 39 minutes, 42 seconds, Moscow time. Astronomical observatories in Alma-Ata, Byurakan, Abastuman, Tbilisi, Stalinabad, and in many other cities observed the artificial comet at the constellation Aquarius with coordinates which were very close to those estimated. Photographs, obtained with light filters which separate the spectral sodium line, made it possible to determine the size, structure, and development at the time of the sodium cloud. This formation became visible after its size had reached considerably large proportions, and was observed for 5-6 minutes with maximum clarity, and approximately equal from the 4-5th star magnitude. The sodium cloud reached 600 km in diameter upon observation by the Abastuman Observatory in the Academy of Sciences of Georgia, SSSR.

Table 1 shows a calendar for the movement of the second space rocket indicating the approximate time values of the main events which accompanied this historic flight.

A special automatic measuring complex (sets which were placed in various points of the USSR) worked successfully, constantly measuring the parameters of the movement of the rocket. The actual trajectory of the flight was continually and accurately specified according to the radio measurements of the current ranges and angles which determined the position of the rocket, and according to the measurements of the radial speeds. The results of the measuring and the determination of the elements of the orbit of the rocket were computed in a coordination-computing center by high-speed electronic computers, which made it possible to predict with satisfactory accuracy the movement of the rocket, to compute the data of the target designations and to communicate them early so that they might be transmitted to all the radio sets of the Soviet Union.

The results of current measurements indicated that the actual trajectory of the movement of the space rocket is very close to that which had been estimated. One mav judge this by the final result — by the area of fall of the carrier on the moon. The computed center of the area of fall was placed on the center of the lunar disc with selenographic coordinates 0% longitude and 0% latitude. The actual center of the region of fall has selenographic coordinates 0% longitude and 30% northern latitude; that is, it was placed on the vertical which divides the lunar disc in half, and approximately 800 km to the north of the center of the visible disc of the moon. The radius of the area of fall is about 200 km.

Such high accuracy in maintaining the rocket on a set orbit was ensured by a whole series of measures, tied up with a perfectly worked out system of control methods of switching off the engine assemblies of the rocket, along with an insignificant deviation in time of the take off of the rocket from the optimum designated time, the development of methods for accurately computing the trajectory of the movement of the rocket, and a number of other measures.

The pull of the earth, the moon, and the sun, the relative position and movement of these bodies, including the rotation of the earth around its axis, were taken into consideration when the trajectory of the cosmic rocket was computed using high-speed electronic computers.

Moreover, attention was paid to the deviation of the field of gravity of the earth from the central field due to its compression.

TABLE 1

Date (Moscow time)	Distance of rocket (in thousands of km)		Chief events
	from earth	from point of impact with moon	
12 September			
10 hours	0		Launching of second Soviet space rocket
15 hours	78		
17 hours	101		
18 hours	112		
21 hours	142		Sodium cloud formed (artificial comet), photographed by a number of observatories
21 hours 40 minutes	148		
22 hours	152		
13 September			
00 hours	171		
3	198		More than half way to moon
6	224		More than two-thirds of way to moon
9	250		
12	274		
115 [sic]	298		
6 hours 40 minutes	312	65.2	Rocket entered sphere of moon. Speed of rocket 2.31 km/sec.
18	322	53.9	

19	330	45.5	Speed of rocket relative to moon is 2.33 km/sec.
21	346	28.6	
14 September			
00 hours 02 minutes 24 seconds	371	0	Rocket reached surface of moon Speed of rocket relative to moon is equal to 3.3 km/sec.

The actual moment of time of the take-off of the space rocket deviated from the expected time by only one second. Such high accuracy can be evaluated completely only when all the complex nature of the ground and shipboard systems which were put into operation in order to start the multistage space rocket are taken into consideration.

The target area of the carrier with the scientific and measuring apparatus was located in the western part of the Sea of Rain, which adjoins the Sea of Serenity, and the center of the target area is between the crater Archimedes and the crater Autolycus. The target was determined on the basis of the continuous measuring of the elements of the actual trajectory of the movement of the space rocket up to the very moment of its impact with the moon and the utilization of additional radio technical means as the rocket approached the lunar surface. The operation of the radio equipment installed in the carrier ceased the moment that it came in contact with the moon.

Three emblems made of stainless steel with a picture of the coat-of-arms of the Soviet Union and with the sign "Union of Soviet Socialist Republic, September 1959." were established on the surface of this heavenly body in honor of the first flight to the moon made by man in the history of mankind. Two emblems(Sphere and Tape) were placed in the carrier and one (Sphere) in the last stage of the space rocket. Special design measures were taken to ensure the preservation of these emblems upon impact with the moon. Future astronauts will find the five-cornered element of the emblems and the tape emblem in the area around the craters of Archimedes -- Aristillus -- Autolycus, where the container with the equipment landed on the moon, and the five-cornered element of the emblem in the region where the last stage of the space rocket landed on the moon.

In order to pass judgment on general laws for development of life, it is not sufficient to know just the development of the form which exists on earth. This can be done by studying and theorizing about the data concerning the existence of living forms on other heavenly bodies, but these living forms can be altered by earth's micro-organisms, if they are imported to one or another of the heavenly bodies by the rocket which has fallen on them. In order that this not happen, sterilization methods should be taken to prevent the possibility of infecting the lunar surface with earth's micro-organisms.

Since there is an exceptional variety of manifestations of the lower forms of life which are known to us on our planet under the most and, it would seem, improbable conditions of low and high pressures and temperatures, and also when there is a lack of oxygen, it would not be surprising if, in the ground of certain regions of the moon, the existence of the simplest micro-organisms were detected. We must be ready for this.

The processing of the results of the investigations is evidence of the normal functioning of the scientific and telemetering apparatus installed in the carrier of the space rocket. Meticulous and time-consuming processing of all of the abundant material which has been obtained must precede any conclusions or conjectures drawn; however, preliminary decoding of the data of the telemetry has already made it possible to come to some conclusions that are extremely important. Thus, according to the data from readings of the magnetometer, within the limit of its sensitivity and deviation error, stands about 60 grams (there was no magnetic field on the moon detected). Measuring the intensity of radiation around the moon did not cover a radiation belt of charged particles. However, the four ion traps of the carrier registered current amplification as the rocket approached the moon at a distance of approximately 10,000 km, which can be explained either by the existence around the moon of a cloud of ionized gasses (lunar ionosphere) or by the presence of a field of increased concentration corpuscles with energies of scores of volts.

An important contribution to experimental cosmology is the investigation of cosmic radiation and its streams of nuclei of helium, carbon, nitrogen, oxygen, and heavier nuclei; the investigation of gamma and X-ray radiations and electrons of various energies; measurements within the radiation belt of the earth; information on micro-meteorites; and other research taken on the travel line of the rocket from the earth to the moon.

We must extend our congratulations to Soviet scientists, designers, engineers, technicians, workers, and to the whole collective of participants in the creation and launching of the second Soviet space rocket to the moon: and send our greetings, directed along this line, to the Central Committee of the Communist Party of the Soviet Union, the

Presidium of the Supreme Soviet, and the Council of Ministers of the USSR, of the Soviet republics and foreign countries, as our country once again has won a new brilliant victory in the struggle for the conquest of space.

Twenty days after the rocket reached the surface of the moon, a third Soviet space rocket was launched. The chief aim of the flight of this space rocket, which was successfully launched from the pad on 4 October 1959 at approximately 4 A.M., Moscow time, was to fly beyond the moon to photograph the side of the lunar sphere which is invisible from the earth and to transmit this image to the earth. In order to ensure a swift flight close to the moon and to be sure that the rocket is on a new orbit of the sputnik of the earth with an apogee of approximately one half a million kilometers, the trajectory of the flight had to be deformed considerably in order that the pull of the moon might be utilized. The unique trajectory which was selected made it possible to control the flight of the rocket (during its launching and its return) from the northern hemisphere of the earth, where stations were located for observation and communication with the rocket. Such a complex trajectory was feasible in an energetic ratio. However, in order to accomplish this it was necessary to increase the accuracy of the rocket on orbit. This accuracy was reached. At a given moment of time, the rocket flew a set distance of about 6,000 km from the surface of the moon, having a scedvector.

In order that the rocket could go beyond the moon and return to the earth, the speed of the flight was taken at several tens of meters per second less than the second cosmic speed. Therefore, the flight time of the rocket to the moon (61 hours) was approximately one day longer than previous flights, made with a speed which somewhat exceeded the second cosmic speed with a hyperbolic speed.

The flight of the third space rocket took place with only an insignificant deviation from the computed trajectory. The measuring elements of the trajectory hardly varied from that which had been computed beforehand. The accuracy of putting the rocket on a set orbit doubtless made it possible to solve positively problems in the launching of Soviet space rockets along even more complicated trajectories.

One should know that, in order to compute the trajectory of interplanetary flights, the accuracy which we know at the present time of astronomic determinations of orbit elements and movements of the heavenly bodies in our solar system is not sufficient. Even at a given beginning stage of development of interplanetary flight, the proverbial astronomical accuracy cannot satisfy the requirements, and our knowledge of astronomy constants must be made even more accurate by using space rockets.

An automatic interplanetary station, detached from the final stage of the rocket after it went into the planned trajectory and the engine assemblies switched off, was installed on board the third cosmic multistage rocket. This station was intended for broad scientific research in space and was equipped with scientific, television, and radio equipment, as well as systems for adjusting and automatically controlling the heat system. The scientific and radio equipment on board was electrically fed from solar batteries and chemical current sources.

The weight of the last stage of the rocket, without operating reserve of fuel, was 1553 kg; the weight of the useful load -- 435 kg -- was made up of the weight of the automatic interplanetary station (373.5 kg) and the weight of the measuring equipment with the power sources (156.6 kg), housed in the final stage of the rocket. The shape of the station was a cylinder with spherical bottoms; the maximum cross section measured 1.2 m, the length -- 1.3 m (without antennas).

Scientific information and results of the measuring of the movement parameters of the automatic interplanetary station were transmitted by two radio transmitters, working on frequencies 39.986 and 183.6 mgts. At the same time the element of the orbit of the interplanetary station was controlled through a radio link with a frequency f 183.6 mgts. The signals of the transmitter, on the frequency 39.986 mgts, were impulses which varied from 0.2 to 0.8 seconds with a repetition rate of 1 ± 0.15 gts. The approximate time values of the flight of the rocket, along with the indication of the distance from the earth and the moon and with a summary of the chief events which took place during the flight, are shown in Table 2.

Operating periods lasting from one to four hours for the transmission of information from on board the automatic interplanetary station was carried out daily from the 4th to the 9th of October, and then less frequently, along an established program of observations. The operation of the equipment on board was directed from the earth, from a coordination-computing center. The parameters of the rocket were measured by an automatic measuring complex, whose ground stations were located at various points in the USSR.

The preliminary processing of the telemetering measurements is evidence of the normal functioning of the equipment for scientific research, the systems of heat regulation, and the power supply of the automatic interplanetary station. The temperatures and pressure inside the station were normal. The basic equipment of the automatic interplanetary station, intended for photographing the other side of the moon invisible to the earth, worked normally.

TABLE 2

Date (Moscow Time)	Distance of rocket (in thousands of km)		Chief events
	from earth's surface	from moon's surface	
<u>4 October</u>			
4 hours	0		Launching of third Soviet space rocket. Leading into trajectory, and separation of automatic interplanetary station from rocket.
13 hours	108		
18 hours	145		
<u>5 October</u>			
12 hours	243		Automatic station has passed two-thirds of way to lunar orbit.
20 hours	284		
<u>6 October</u>			
17 hours 21 minutes		6	Automatic station has passed minimum distance from moon's surface, equal to ~ 6100 km.
20 hours	372	15	Automatic station reaches part of lunar sphere invisible to earth
<u>7 October</u>			
6 hours 30 minutes		65	After operation of orientation mechanism a series of photos of the reverse side of lunar hemisphere is made.
20 hours	417	126	

TABLE 2 (continued)

<u>8 October</u>			
20 hours	448	235	Automatic station, circling the moon, has left the sphere of its pull and moves toward its apogee at a speed of 0.5 km per second.
<u>9 October</u>			
20 hours	460		
<u>10 October</u>			
22 hours 43 minutes	474		Automatic station reached with speed of 0.4 km/sec. within 6 days 19 hours after launching.
<u>12 October</u>			
20 hours	456		
<u>15 October</u>			
20 hours	339		Speed of station ~0.9 km/sec.
<u>16 October</u>			
20 hours	267		Speed of station ~1.2 km/sec.
<u>17 October</u>			
20 hours	166		Speed of station ~1.7 km/sec.
<u>18 October</u>			
19 hours 50 minutes	41		Automatic station reached perigee with speed of 3.91 km/sec.

The interplanetary automatic station, on 6 October at 17 hours 21 minutes, reached a minimum distance from the surface of the moon, and then went beyond the moon passing to the side which is invisible to the earth. After the automatic station had reached the other side of the moon and was located at a small angle to the line connecting the moon and the sun, which illuminates about 70% of the invisible side of the moon, the mechanism for adjusting the station, which guided two long-focusing (200 and 500 mm) lens of its photographic equipment on the lunar surface, was put into operation. The adjusting system consists of solar and lunar optical data units, gyroscopic data units, logical electronic equipment, and control engines. After the station was automatically adjusted, a large series of photographs was made in the course of 40 minutes on two different scales with a diverse exposition on a special 35 mm film. In addition to this, the distance to the moon was approximately one-sixth of the distance of the moon from the earth. The negative film was automatically developed, fixed, and dried under conditions of weightlessness. Steps were taken to preserve the photographic materials under cosmic illumination conditions. The image was transmitted upon command from the earth on two schedules: slow -- at great distances (up to 470,000 km), and swift -- near the perigee. The maximum number of lines in the frame of the half-tone of the televised picture reached 1,000. The signals of the televised picture of the moon were fixed by ground receiving points using various equipment for film, for the magnetic tape, and electro-chemical paper, and in the skiatrons.

The photographs with negative film, which automatically rewound frame after frame upon command from the earth, were successfully televised to the ground and made it possible to effect this experiment which was unprecedented in the history of mankind.

A picture of the reverse side of the moon which is invisible from the earth was received. One more cover fell from the secrets of the universe.

The total volume of scientific information received from on board the station along channels which included the picture area of the moon, somewhat exceeds the volume of information obtained from the first and second Soviet space rocket.

As the automatic station moved further, it went into the orbit of the earth's satellite with an apogee of 480,500 km, a perigee of 47,500 km (distances given from the center of the earth) and a revolution period of 16 days.

The earth was presented with a new satellite with an unusually high perigee and apogee. If the third Soviet sputnik completes 15 revolutions around the earth per day, then the new satellites will make one turn every 16 days; that is, it will have a 240 times longer period of revolution.

Despite the exceedingly high perigee and apogee, the new satellite will not last forever. Moreover, it will not last a long time and it will exist very likely only about one half year, since the unusual elongation of the orbit will result in a significant disturbance on the side of the sun, as a result of which the apogee will grow and the perigee diminish until the satellite, in time, enters the dense layers of the earth's atmosphere and burns up. (On the first revolution, the apogee was equal to 480,500 km and after 16 days (26 October at 22 hours 43 minutes) on the second convolution the interplanetary station reached an apogee of 489,100 km.) As it approaches the moon, disturbances are possible on subsequent convolutions which will either lengthen the period of existence of the station or it will decrease it, depending upon the nature of the approach. The trajectory measurements and computations make it possible to feel that the automatic interplanetary station, revolving around the earth in orbit close to the ellipse with an apogee of about 500,000 km, will complete eleven revolutions and at the end of March or the beginning of April 1960 will enter the dense layers of the earth's atmosphere and burn up.

The tendency to photograph a possibly larger part of the unknown surface of the moon during this photography would lead to the necessity of photographing almost all of the illuminated disc, when the picture has the least contrast. Therefore, the processing and study of these photographs presents definite difficulties and demands a great deal of time.

The Soviet people, as the first discoverer, reserve the right to name the mountains and valleys, craters, and cirques of the opposite side of the moon. In a newly constructed map there will no longer be a "Sea of Cold," nor "Ocean of Storms," nor "Lake of the Dead," nor "Marsh of Sleep," nor "Marsh of Decay." World peace, friendship and progress -- these are the banners which the Soviet people wave.

The Committee of the Academy of Sciences of the USSR for naming formations on the opposite side of the moon, under the chairmanship of member-correspondent of the AN [Academy of Sciences] USSR, A. A. Mikhaylov, began its activities. Thus we now have the Soviet Mountain Range, the Moscow Sea with the Bay of Astronauts, the Sea of Dreams, the craters of Tsiolkovskiy, Lomonosov, Joliot-Curie.

A number of formations located on the very edge of the lunar disc visible from the earth and, therefore, one with a strongly distorted perspective, were obtained in the photographs practically without any distortions at all, and this made it possible to establish their actual form and size. This refers to the Humboldt Sea, the Sea of Waves, and particularly, the Mare Marginis, the Sea of Smyth, and the Southern Sea, which has an extension on the surface of the moon not seen from the earth.

On the photographs, made from on board the interplanetary station, there are also objects seen from the earth; this makes it possible to tie up objects observed for the first time to those already known to us and must determine their selenographic coordinates.

The processing and study of the materials of the televised transmission, received from the automatic interplanetary station, has continued. The essential difference in the relief of the lunar surface of the reverse side of the moon from that seen from the earth has been unexpected. The newly discovered surface of the moon bears a continental nature and has few seas.

The distribution of the objects on the visible side of the moon, which has appeared in the preliminary study of the photograph obtained from on board the automatic interplanetary station, is shown in the inset.

*

The third Soviet space rocket was launched two years to the day from the first artificial earth satellite. For the two years from the first break through into space, Soviet science and technology trod the triumphal path of victory.

The launchings of the three Soviet rockets in 1957-1958, which was crowned by their entrance into the orbit of the heavy earth satellites, were devoted to the study of the properties of the outer layers of the atmosphere of the earth and the cosmic space adjacent to it. Each subsequent one of these three satellites was heavier, rose higher, and flew further than the preceding one, and was better equipped with scientific equipment (see Table 3).

In 1959, the USSR launched three space rockets for the purpose of studying the moon and the space adjacent to it: on the 2nd of January — a flight into the region around the moon entering, on the 7th and 8th of January, the orbit of the perpetual solar satellite; on the 12th-14th of September the flight reaching the moon, and on the 4th of October — the flight around the moon entering the orbit of the earth's satellite

TABLE 3 (Left side)

Name of Sov. artificial earth satellite	Date of launching	Weight* (kg)	Form and size	Orbit elements** (beginning) Perigee (km)	Apogee (km)	Rotation period (min)
Satellite I	4 Oct. 1957	83.6	Sphere, diameter 0.58 m (without antennas)	228	947	96.17
Satellite II	3 Nov. 1957	508.3	Conic assembly of spherical and cylindrical carriers with additional aggregates	225	1671	103.75
Satellite III	15 May 1958	1327	Cone, base diameter-1.73m; height-3.57m (without antennas)	226	1880	105.95

*Weight given without computing weight of last stage of rocket-c carrier.

**Tilt angle of orbits of satellites to the earth's equator plane is equal to 65°.

TABLE 3 (Right side)

	Chief events	Date of fall	Existence time (in days)	Number of completed revolutions	Path completed (in millions of km)
Satellite I	Propagation of radio waves of two frequencies, density of atmosphere, temperature and pressure in carrier, operation of heat regulation, and power supply by electrochemical batteries under satellite conditions	4 Jan. 1958	92	~ 1400	~ 60
Satellite II	Vital activity of experimental dog "Layka" (pulse, breathing, arterial blood pressure, electrocardiogram, movement) in the cabin of the satellite, cosmic rays, solar ultraviolet and X-ray radiation, temperature inside and on the surface of the satellite pressure in the cabin and carrier, propagation of radio waves of two frequencies, density of atmosphere, operation of electrochemical power supply, air conditioning (temperature, composition, humidity) and other provision for vital activity of animal.	14 Jan. 1958	162	~ 2370	~ more than 100
Satellite III	Atmospheric pressure, composition of air, concentration of positive ions, electric charge of satellite, voltage of electrostatic field of earth, magnetic field of earth, intensity of solar corpuscular radiation, composition and variations of primary cosmic radiation, distribution of photons and heavy nuclei in cosmic rays, micro-meteors, temperature inside and on the surface of the satellite, pressure in satellite, operation of heat regulation system, system of power supply	Expected first quarter of 1960	Expected ~ 600	Expected ~ 9000	In flight***

TABLE 3 (Right side, continued)

	Chief events (cont'd)
Satellite III	by solar silicon and electrochemical batteries, propagation of radio waves, density of atmosphere, exact measurement of movement in orbit of the special radio technical equipment on board (for automatic recording of scientific observations with subsequent transmission to earth by program-time and memory device).

***The radio set on board the satellite, supplied by solar battery, continues to transmit signals.

TABLE 4 (Left side)

Name of Soviet space rocket	Launching date	Final weight of last stage of rocket	Payload with supply sources	Chief Route and Orbit Elements
First space rocket	2 Jan. 1959	1472	361.3	Flight in the vicinity of the moon at a distance 5000-6000 km from the lunar surface along a hyperbolic trajectory with an exit to the elliptical orbit of the first artificial solar satellite, located between the orbits of the earth and Mars. Maximum nearness to orbit of Mars-15 million km. Perigee-146 million km; aphelion-197 million km; centering error-0.148, rotation period-450 days, maximum speed in orbit-32.5 mm/sec, minimum speed-23.7 km/sec, large axes of orbits of rocket and earth from an angle $\sim 15^{\circ}$, the slant of the orbit of the rocket to the plane of the earth's orbit- $\sim 1^{\circ}$.
Second space rocket	12 Sept. 1959	1511	390.2	Flight to the moon along a hyperbolic trajectory. Selenographic coordinates of the center of the impact area 0° longitude and 30° latitude. Angle of impact with surface of the moon 60°, speed of impact with lunar surface 3.3 km/sec.
Third space rocket	4 Oct. 1959	1533	435	Flight along elliptical trajectory with flight around the moon at a minimum distance 6000 km from the lunar surface with entry into the elliptical orbit around the earth with rotation period of 16 days, perigee of 41,000 km, and apogee of 474,000 km. The planes of the orbits of the automatic interplanetary station and moon are almost perpendicular to each other.

TABLE 4 (Right side)

	Chief Investigations	Time of flight	Path completed
First space rocket	Intensity and variations of intensity of cosmic rays, photons and heavy nuclei in cosmic radiation gaseous components of interplanetary substance, corpuscular radiation of the sun, magnetic fields, radiation belt, passage of radio waves from distances up to 0.5 million km, temperature and pressure in carrier with instruments, measurements of elements of actual trajectory of flight, artificial sodium cloud, meteor particles.	Unlimited. To the moon— ~34 hours. Minimum distance from surface of moon 5000-6000 km was reached on 3 January 1959 at 18 hours, Moscow time.	Unlimited
Second space rocket	Magnetic fields of earth and moon, radiation belts around earth and moon, intensity and variations of intensity of cosmic radiation, heavy nuclei, gaseous components of interplanetary substance, meteor particles, sodium cloud, ion currents in traps, temperature and pressure in carrier, long-range radio communications, measurements of elements of actual trajectory.	To the moon— ~38.5 hours. Rocket neared the moon—14 Sept.1959 at 00 hours 02 min 24 sec, Moscow time	371 thousand km
Third space rocket	Photographing of reverse side of the moon, invisible from earth, and televised transmission of images to earth. Investigation of cosmic space and cycle of automatic interplanetary station on board through equipment and systems, chiefly through analogous use in the second space rocket.	To moon— ~61 hours Minimum distance from surface of the moon 6100 km was reached 6 Sept. 1959 at 17 hours 21 min, Moscow time. Expected time of flight around the earth—approximately half of a year [6 mos].	In flight

with an apogee 75,000 km larger than that of the moon (see Table 4). Up until the present time, the moon, as well as other heavenly bodies far from us, was studied only by remote visual methods and by photographic, photometric, thermometric, spectrometric, polarimetric, and radio astronomical methods. However, the possibility of these methods is extremely limited. Astronomical observations of heavenly bodies are limited to a very great degree by the influence of the earth's atmosphere. It is known that due to the fact that the optical heterogeneity of the earth's atmosphere distorts the pictures, it is not possible to utilize optical instruments to the fullest extent. Enlargements of less than 500 times, and up to 1,000 -- in extremely rare cases -- are usually used both in powerful instruments as well as in the weaker instruments. At the very same time, the optics of the instruments make it possible to enlarge it many times larger (for the large instruments -- tens of times).

The influence of the earth's atmosphere also limits the possibility of spectroscopic and other research methods in astronomy.

The construction of a heavy, well-controlled artificial earth satellite, equipped with a strong telescope with automatic remote homing, could open the curtain which for centuries has concealed the cosmos from the eyes of man.

One must not overlook the fact that these very same curtains remain on other planets in the atmosphere. In the first place, this concerns Venus and the giant planet. Only the space rocket surveyors, which have penetrated the mass of such an atmosphere, will be able to communicate to us the details of the construction of these planets. The transparent atmosphere of Mars makes it possible to study immeasurably better its surface by using a telescope, installed on the artificial earth satellites, Mars, or on interplanetary rocket-surveyors.

The construction of an observatory outside the earth will result in a tremendous jump in the development of astronomy. There is no doubt of the expediency of constructing a constant astronomical observatory in a heavily controlled earth satellite. However,it is necessary to provide for high-grade transmittal of images on film from the observatory to the earth. Every distortion during transmission, for example a television transmission, can essentially lower the advantages of an outer-space observatory or even bring its importance to nil. Regular delivery of cassetes with photo materials is very desirable. In the case of television transmittal, it is necessary to ensure the number of lines in a frame, which measures at the most several thousand, which would be quite technically possible if the photographs were transmitted by television. Moreover, the necessary length of the transmission of each picture is quite long.

In connection with the development of rocket technology, science, at the present time, has closely approached the problem of direct study of the heavenly bodies.

Such development of rocket technology has made not only astronomy but astrophysics an experimental science. It is just this circumstance which is the most important result of the recent achievement in the field of research into space and other heavenly bodies, and this was the chief aim for the further development of rocket methods of research.

But one should not think, therefore, that the flight of man into cosmic space is a unique or the primary task. This flight, which will undoubtedly take place after research into cosmic space using automatic rockets is sufficient for ensuring safety, will by itself become a definite stage in the study of the cosmos, tied up with the solving of problems which cannot be done using automatic equipment.

Industrial use of the material resources of other heavenly bodies and the "interplanetary tourism" at the present time can hardly be viewed as realistic or even, at the most, economically feasible, which would force us to approach this problem from another point of view. One can suppose also that even after the flight of man has been accomplished, the role of automatic rockets in the investigation of the cosmos and of other heavenly bodies will remain, as before, a very large and important event. In conformance with the whole tendency to increase the role of automatization in production in scientific processes, automatic rockets will be perpetual aids to man in the investigation of the universe, in effecting various stages of this research.

For example, when the flight from the earth to the moon with a good landing and return to the earth is accomplished, it is feasible to make the launching of the rockets from earth and their entrance into the trajectory of the flight to the moon completely automatic, but also, the flight, including a soft landing on the lunar surface which would demand special accuracy in order to avoid damage. But this refers not only to rockets without a crew when no other solution exists. At the modern level of the development of electronics and rocket technology, there is no necessity for man to trust his execution of the responsible and complex maneuver of a good landing on heavenly bodies. Moreover, an automatic guidance system, which utilized a radio altimeter, a computer, and other instruments, would make landing incomparably safer, better, and with less expenditure of fuel. Along this same principle, it is expedient to make the launching from the moon completely automatic and the landing on earth when the rocket returns, depending upon the content of the efficient load of the rocket.

The high speeds and accelerations of the flight, which demand swift acceptance of the best solution, the complexity of the circumstances, the inadmissibility of error, and the imperfection of the possibilities of a human pilot exclude manual guidance of the rocket. The flight to the moon and return to earth will probably be executed automatically according to a program earlier computed on earth and would be automatically corrected in the process of flight. Without exception this correction will be determined in a ground computer center having radio communication with the rocket and tracking its flight. One should keep in mind that the landing system of the rocket on the moon must act autonomously from the instruments on board inasmuch as the distance of the moon from the earth requires 2.6 seconds just to transmit radio signals the moment an answer to a question is sent. In order to ensure a successful landing, high-speed guidance systems must be measured to hundreds of parts of seconds.

It is possible that even the area which is suitable for landing the rocket can be selected by the use of automatic equipment, installed on board the rocket and guided by a braking rocket engine as it approaches the lunar surface.

Just what practical significance can space rockets have in investigation and how can they be effected? This question bothers the majority of people at the present time. Of course, it is difficult now to grasp all the possible prospects which could develop before science after this material which has already been obtained has been processed and studied, as well as that material which can be received in subsequent experiments -- the majority here can reach quite an unexpected amount. The value of space investigation can be represented in the following way.

To begin with, detailed and thorough investigation of other heavenly bodies in conjunction with space and geophysical research will give experimental data for checking cosmogenic concepts which exist at the present time, make it possible to obtain reliable material for judging the origin and evolution of all the bodies of the solar system. There is no doubt that this will be exceedingly important for the most effective utilization of the natural resources of our planet, and for knowledge of the elemental forces of nature. Thus, as we see, a "reverse communication" can easily take place during cosmic research, and "heavenly" interest in science can completely serve the "earthly" needs of man.

It is quite evident that from this point of view the study of the moon is of exceptional interest. There is reason to suppose that the moon has its origin in common with the earth, and that it separated from the earth in the beginning stage of its evolution. From the astronomical point of view, the earth and moon can be examined as a dual planet inasmuch as the relationship of their size is closer than for other planets and their satellites. It has been assumed that evidence of the break of the moon from the earth is the ratio of its average specific gravities; that of the moon is much less than that of the earth. In order to judge this better, it is necessary to know the structure of the moon and the processes which take place in its interior, which can be done both by the direct study of the lunar interior, as well as by indirect methods. One of these indirect methods is the study of the lunar atmosphere, which was detected as a result of observations of the stars, which emit radio waves along with a visible light. (At the moment that the rocket approaches the edge of the lunar disc, the pictures of the stars, obtained through radio telescopes and optical instruments, break apart. This can take place only where there is an ionized atmosphere around the moon.) The result obtained from the second space rocket, which detected an accumulation of ionized particles around the moon, confirms the deduction that atmosphere exists on the moon. The atmosphere of the moon is extremely rarefied even compared with the upper layers of the earth's atmosphere.

When the moon is small, the existence of such an atmosphere can be explained only by the weight, the high specific gravity of the components of its gases (for example, those which have the gases radon and xenon), as well as the constant entrance of gases from the interior of the moon and by their separation merits as a result of some one or another process.

In any case, knowledge of the composition of the atmosphere of the moon is very important both from the point of view of a study, and from the point of view of obtaining material learning about its evolution. One should note that the composition of the moon's atmosphere will be altered by products of earth origin just like the influence of the earth's micro-organisms as a result of rockets landing on the moon. The analogy is not complete inasmuch as contamination of the atmosphere of the moon by gases of earth origin is temporary, since they are very volatile due to the fact that the force of the moon's pull is very small.

The landing of the second Soviet space rocket on the moon did not cause any noticeable alteration in the composition of the lunar atmosphere. Even if, as a result of the blow, part of the material of the rocket and lunar rock evaporated at the place of impact, then the products of this evaporation, under normal lunar conditions, will be extremely fine particles of a hard substance.

The method for studying the moon, which excludes the possibility of introducing earth gases into its atmosphere, is the study using artificial satellites. The insignificant density of the lunar atmosphere makes it possible to place the orbits of these satellites as close as one wishes to the surface of the moon, and the time of their existence can be very long. The scientific program of the experiments placed in these satellites can include both a detailed study of the surface of the moon and its physical properties, using various optical and radio physic methods, as well as the study of the surrounding area of the moon and of its atmosphere. Therefore, in order to systematically observe and study the moon and its surrounding cosmic space, it is expedient to build moon satellites, equipped with an automatic scientific, television, and radio telemetering station.

The investigation of the physical properties of the moon and its surrounding area using artificial satellites, besides those worthwhile qualities mentioned above, has certain essential defects. The first of these consists in the fact that the study of the surface of the moon and its interior will be, all the same, indirect, and not free from the various assumptions and premises. The second lies in the fact that using the satellites it is difficult to receive continuous measurements in time (or, as they say in geophysics, time variations) of some one or another parameter at a definite point of the lunar surface. One and/or the other will be eliminated in case the automatic scientific stations are delivered to the moon without impact. Conducting investigations of such a type will be most effective if along with decisions concerning the problems of delivering scientific equipment to the moon, the problem of its return to the earth is also solved. It is difficult to foresee the entire scientific program of investigations of this type. One can suppose that a percussionless launching at various areas of the moon of a long term or continuously operating automatic stations with scientific-research, television, and radio telemetering apparatus will make it possible to determine the heat cycles, levels, and compositions of various radiations which exist on the surface and in the ground, to determine the composition and structure of the lunar rock, and to carry out a number of other investigations in a broad program.

Thus the study of the micro-relief of the lunar surface also stands before us. We must not eliminate the possibility that the surface of the moon, even in the areas of the calmest relief, which are named "seas," "bays," "lakes," and "marshes," is speckled with fissures, hollows, and covered with protuberances, both large in width and expanse, as well as fine particles, which present a danger when the rocket with the automatic station lands. There are also assumptions that the lunar surface is covered with a deep layer of very fine dust in which the rockets will submerge.

In order to ensure that the automatic scientific stations land softly, the soft landing with a shock-absorbing chassis with an operating break engine must be unconditionally worked out.

Knowledge of the composition and mechanical properties of the lunar soil, selection of areas suitable for a safe vertical landing of the rockets, and knowledge of the micro-relief of these areas makes it possible to construct correctly shock-absorbing landing gear. These same landing gears can serve for a vertical launching of the automatic rocket back to earth along with delivery of samples of lunar rock to the earth's surface. Such flights of the rocket prospectors, with the purpose of working out a soft landing and return launching, must precede an expedition of the moon.

The insignificant density of the lunar atmosphere does not make it possible to use it for slowing down rockets; therefore, the only method for effecting a soft landing is to use the rocket engines for this purpose. This can unconditionally lead to a temporary contamination of the lunar atmosphere with combustion products, which must be taken into consideration during the planning of the experiment. It is also necessary to keep in mind that when the automatic scientific station makes a soft landing the surface of the moon at the point of landing will be destroyed and sprayed with incandescent gases, expelled from the nozzle of the jet engine which is used for braking when the rocket comes down. As a consequence of this, the analysis of the composition and structure of the lunar soil and micro-relief, directly on the landing spot, will not give true information about its ground covering. Therefore, after landing, the automatic scientific station must be removed from the shell of the rocket and taken to a distance no less than several tens of meters from the landing spot in case the lunar surface is covered with hard rock, and no less than hundreds of meters if it is covered with a layer of dust. Then the equipment of the station can study the primeval covering of the moon both from the surface, as well as deep samples.

It is now very difficult to present the entire complexity of the technical realization of such experiments, which are under conditions which are quite unknown to us. Thus, for example, the self propelled automatic scientific station delivered to the lunar surface evidently must be equipped with electronic apparatus, which will make it possible to adjust autonomously in the micro-relief, to avoid falling into the fissures and hollows, and to by-pass sharply elevated obstacles. In time, automatic scientific stations can be created which will circulate throughout the lunar surface which is available to them, studying all the angles of the moon and transmitting to the earth not only televised pictures, but also the results of a detailed examination of the nature of our natural satellites. Electric power, necessary for feeding the systems on board, the scientific apparatus, radio transmitters, and electric motors, which serve to motivate the automatic station, evidently can be ensured by using solar semi-conductor batteries along with buffer electro-chemical batteries, which work when the station is temporarily in the shade.

Investigating the moon must bring to life a number of new fields of knowledge.

Similarly, such sciences as selenology, selenophysics, and selenochemistry will develop, apparently, just like the sciences we all know, such as geography, geology, geophysics, and geochemistry.

The problem of returning the equipment to the earth can be solved by various methods, but they are all tied up with preserving reserves of fuel necessary for returning the rocket to earth under severe lunar conditions lasting for a more or less long time. This task will be far from simple inasmuch as sharp daily variations in temperature of the surface of the moon within a wide range are characteristic for the moon: from +132° in the day time, when the sun is in its zenith, to -160° at night. The temperature of the locale changes during the lunar days (29.53 earth days) within these ranges depending upon the height of the sun and the time of night.

In order to preserve fuel on the moon, areas are desirable that are less hot and which have a less change in temperature. Such regions are in the places where the solar rays light up the lunar surface at a small angle. Depending upon the slant of the solar rays, one can find a surface with an acceptable temperature, for example, in the narrow regions along the line of the terminator, even in the polar regions. However, the use of the terminator area presents great difficulties due to the movement of the terminator along the surface with a speed due to the rotation of the moon (from 0 at the poles to 15.4 km/chas [kilometers per hour] at the equator).

Due to the insignificance of the slant of the lunar equator to the ecliptic plane, the region with a relatively constant temperature of the surface, close to -50°, which enters the position of the sun at the very horizon, is very small and located directly at the poles of the moon. In the course of the lunar day, the temperature of the surface does not rise above 50° in the polar regions with a latitude of more than 70°. The temperatures cited are averaged, taking into account cross section of the relief.

It is very likely that the polar regions of the moon will, therefore, be the most suitable for landing and reverse launching of rockets and also for preserving fuel carriers.

Placing the fuel containers at a shallow depth in the lunar ground makes it possible, evidently, to regulate the contents thermostatically when the temperature is low. Due to the exceptionally heat conductivity of the outside layer of the lunar ground, the temperature at a depth of less than a meter is equal to approximately -110^o and it is assumed to be constant during the lunar days. We must not overlook the possibility of detecting warm zones in the lunar ground located near volcanoes which are still active and have not congealed.

The climatic conditions impose definite limitations on the selection of a fuel, which must be preserved for a more or less long time on the lunar surface. Evidently, when additional protective measures have been carried out and a certain loss in oxidizers from evaporation is permissible, the utilization of low-burning components of fuel, for example, liquid oxygen or liquid fluorine, are either excluded or require only a short stay of the rocket with those oxidizers that are only in an unlighted part of the lunar surface. High-burning components of fuel will have a definite operational advantage when used under lunar climatic conditions.

The technical possibilities and, even more important, the inadequacy of our knowledge of the moon, force us to think that the problem of sending an expedition to the moon is not of primary importance at this particular moment. However, there is no doubt that sooner or later rockets with crews will be sent to the moon. The realization of this stage of research will have great advantages in the sense of obtaining scientific results, but at the same time will complicate, to a great extent, both the realization of the flight itself as well as the work on the moon because of the necessity of ensuring the safety of the crew.

Recently, in literature, there have frequently been deliberations concerning the expediency of using the moon as an intermediary station in interplanetary flight, but this expediency is only illusory.

Organizing an interplanetary station on the moon for servicing flights into space is technically unfeasible, inasmuch as an expenditure of a considerable amount of power is necessary for landing on the moon or taking off from it. Using jet engines, it is necessary to reduce the speed with which the rocket comes in contact with the moon to about 3.3 km/sek [kilometers per second] or approximately twice less, depending upon the length of the flight and the trajectory selected for landing on the moon, and during the take off from the moon to gather the first cosmic speed which is equal to 2.4 km/sek.

The pull of the moon is six times less than that of the earth and a take off from the moon, of course, will demand less expenditure of power than a take off from the earth. However, even these expenditures can be completely avoided if an interplanetary station were built in an artificial earth satellite. Moreover, the conditions for the existence of people on the moon can scarcely be more favorable than in artificial earth satellites. On the moon, it is also necessary to protect oneself from vacuum, solar and cosmic radiation, from meteors and micrometeors. Protection from the high surface of the lunar surface by day and the low temperature by night will become even more complicated when using the polar regions. It is true that on the moon one can build hermetically-sealed housing under the lunar surface, but this would require power for heating and lighting.

In the artificial earth satellite, the problem of protection can be solved by using materials delivered from the earth. However, when the artificial satellite is placed at a correctly selected distance, and on a properly adjusted orbit in reference to the earth, an acceptable amount of material can be required to ensure protection of the crew.

The realization of rocket flights to heavenly bodies, in the first place around the moon and then to the moon, particularly with crews on board, meets with a number of limitations. First of all, the selection of the time of launching and the flight trajectory is tied up not only with the relative position of the earth and the moon when they revolve around their axes and around the sun, but with the necessity of ensuring control of a flight around the moon or landing on the moon from those points of the earth's sphere where observation stations are located.

Furthermore, until sufficient experience has been accumulated, it is impossible to disregard the meteor danger. The probability of a space ship bumping into a large meteor, a type of meteorite, is negligibly small. The very fine meteor dust is not dangerous for, moreover, interplanetary space is continuously cleaned by solar pressure. But meteors with an average size can present a danger. Micrometeors are studied using high rockets and, in particular, earth satellites and space rockets for determining their possible abrasive action on optical systems, solar batteries and construction materials. Cockpits can be protected from sporadic meteors by a sufficiently stable covering or by a screen; however, it is best not to launch rockets during the days when the earth cuts across the orbits of the powerful meteor streams or comets. One should also avoid the trajectory of a rocket flight which cross cuts the orbits of these heavenly bodies.

The degree of danger of meteor streams varies depending upon the size of the particles which form them, their nature, on whether they are iron, stone, or intermediate formations, and also on their speed relative to that of the rocket and on the density of the stream. Several hundreds of meteor streams, moving around the sun along elliptical orbits with a rotation period of from one year to 125 years and more, are known. Also known are the dates of their maximums which enter the cross section of the earth's orbit and these streams, and those days in which it would be more dangerous for the space ship to be on the surface of the earth, under protection of the atmosphere from the most intensive meteor streams. The passage of the earth through a nucleus of meteor streams and comets does not take place each year and continues for a different length of time, inasmuch as the diameter of a cross section of the meteor stream sometimes is several millions of kilometers, and their orbit plane is usually located at a small angle.

Besides the meteor streams which have been studied, there are others still unknown, orbits which do not cross cut the orbit of the earth. Rocket-prospectors of interplanetary space must fill in the gaps in our knowledge.

It is known that the bodies which make up the solar system, including the majority of meteor streams, move in orbits situated primarily in the ecliptic plane. The flight of space rockets outside this plane would decrease the probability of meeting meteors, micro-meteors and other fragments of heavenly bodies. However, flight in such relatively clean areas is energetically less feasible.

Recording the collisions of meteor particles with the third Soviet artificial earth satellite has indicated that the impact of particles with masses approximately from one-eighth billion to two hundred million parts of a gram, which have an energy of about tens of thousands up to hundreds of thousands ergs, were fixed when the equipment was in operation. Moreover, it was established that the particles with a mass of about one billionth part of a gram can meet the surface of the rocket once every several hours. However, on 15 May 1958, the number of collisions was considerably more than in any other day: on this date from four to eleven blows per square meter per second were registered; on 16 and 17 May, the number of blows was decreased four thousand times, then fifty thousand times and, finally, six hundred thousand times.

A consoling factor is the lengthy stay of the third Soviet artificial earth satellite in orbit, making nine thousand revolutions around our planet. The path passed by it for one half year constituted about one-third billion kilometers at the edge of the earth's atmosphere. Moreover, the hermetic qualities of the carrier with the instruments were preserved as well as the efficiency of the system for regulating the thermocycle on board and the solar batteries, and finally the efficiency of the "Mayak" radio transmitter. The value of the observations increases in connection with the considerable size of this satellite (see Table 3). It is evident that no other proof is needed that the acceptance of definite steps will make it possible to make even a space ship livable.

When the time of take off and the flight are selected, it is necessary to take into consideration the situation of solar activity. When the solar activity is high, power thermonuclear processes on the sun are accompanied by gigantic explosions and ejections of coagulums of ionized matter into interplanetary space, as well as by irradiations of high intensity which are dangerous for the passengers on a space ship. The maximums of solar activity are observed, on an average, every eleven years (to be more exact from 7-1/2 to 16 years) and are characterized by an increase in spot formations on the sun, by a rise of powerful protuberances, flares, floccules, intensive radio emissions in waves of centimeter and meteor ranges, magnetic storms, destruction of radio communication, and by disturbances in the ionosphere. It was said earlier that storms on the sun are not possible. However, during the period of sharp maximums of solar activity and during the sharply expressed activity, fixed on the sun, rockets with crews should not be sent into space.

Investigations using artificial earth satellites and space rockets have detected radiation belts surrounding our planet. In the zone of these belts, the intensity of radiation is many times more than the normal level of space radiation and is dangerous for living organisms. The origin and structure of the radiation belts is still under investigation, but it is already clear that it is necessary to develop means which will lessen the dose of exposure received by the crew during flights in this zone. The lower border of the internal belt of radiation, which is closest to the earth, is situated at a height of 500 km in the western hemisphere and 1,500 km in the eastern hemisphere (the asymmetry is caused by a deviation of the magnetic dipole relative to the center of the earth). The upper border of the outer radiation belt is situated at a distance of ten earth radiuses from the center of our planet.

The situation of orbits of inhabitable satellites in this zone is intolerable. Many types of inhabitable satellites can be placed within ranges of height up to 500-1,500 km. The inhabitable satellites which are further away must be at a height no less than approximately 50,000 km. For a satellite which moves around the earth in a circular orbit at a height of 500 km, the speed is 7.62 km/sek, and the period of revolution — 1 hour 34.5 minutes. At a height of 50,000 km, the orbital speed of the satellite is 2.66 km/sek, the period of revolution — 37 hours. The so-called stationary artificial satellite, with a period of revolution around the earth equal to 24 hours, is situated at a distance 42,190 km from the center of the planet; that is, in the zone of increased exposure.

This very same problem arises as the space rocket approaches the other planets of the solar system which have radiation belts. We know now that direct measuring has indicated an absence of a noticeable magnetic field and the radiation belts tied up with it around the moon.

In order to carry out the first flights of a rocket with a crew into space, a whole series of various types of problems must be solved. In the beginning stage of this degree to which space has been conquered, man will be in that very same position as the first discoverers of the unknown seas and oceans were in the early stages of the development of mankind. Storms, underwater reefs, shallow waters, unknown currents, and other difficulties of that time are unintentionally compared with the dangers of the nascent astronavigation -- solar storms, meteor streams, radiation belts, space radiation, weightlessness.

We will see that after a little time has passed, all these dangers will also be overcome in the victorious march of mankind on the path of progress. We are happy that the Soviet country, thanks to its ideals, to social structure, to the development of science and technology, were in the vanguard of humanity.

The triumph of Soviet science and technology fills the hearts of the Soviet people with true pride and, we must think, the hearts of all people who are treading the paths of achievement of man's reason, creating this new epic in history.

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